1. A cube of an ice of mass 100g at -5°C is dropped into a copper container with a water at 70°C. Mass of the copper container is 200g and mass of the water inside of the copper container is 300g. Calculate the final temperature of the system. (specific heat capacity of water is 4200 $J/kg.K^{-1}$, specific latent heat of fusion of an ice is $3,3x10^{3}J/kg$ and specific heat capacity of copper is 400 $J/kg.K^{-1}$, specific heat capacity of ice is 2100 $J/kg.K^{-1}$).

2. How much thermal energy is needed to remove from 3kg of water at 20°C to turn it into ice at -10°C (specific latent heat of fusion of an ice is $3,3 \times 10^{6}$ J/kg and specific heat capacity of water is 4200 $J/kg.K^{-1}$, specific heat capacity of ice is 2100 $J/kg.K^{-1}$).

3. An electric heater has a power rating of 2 kW. How long after the heater is switched on will the water start to boil if its initial temperature is 20°C and its mass is 1,5 kg? (specific heat capacity of water is 4200 $J/kg.K^{-1}$).

Solutions are on the second page!

1. $m_i = 100\,g$
$t_i = -5°C$
$m_{cu} = 200\,g$
$m_w = 300\,g$
$c_w = 4200 \frac{J}{kg\,K}$
$l_i = 3.3 \times 10^3 \frac{J}{kg}$
$t_w = 70°C$
$c_{cu} = 400 \frac{J}{kg\,K}$
$c_i = 2100 \frac{J}{kg\,K}$
$t = ?\,°C$

$m_i c_i (t_i - 0°C) + m_i l_i + m_i c_w (t - 0°C) =$

$= m_{cu} c_{cu} (t_w - t) + m_w c_w (t_w - t)$

$0.1 \times 2100 \times 5 + 0.1 \times 3300 + 0.1 \times 4200\, t =$

$= 0.3 \times 4200\,(70 - t) + 0.2 \times 400 \times (70 - t)$

$1050 + 330 + 420t = 88200 - 1260t + 5600 - 80t$

$1760t = 92\,420$

$t \doteq 53°C$

2. $Q = ?\,J$
$m_w = 3\,kg$
$t_w = 20°C$
$t_i = -10°C$
$c_w = 420 \frac{J}{kg\,K}$
$l_i = 3300 \frac{J}{kg}$
$c_w = 4200 \frac{J}{kg\,K}$

$Q = m_i c_i (t_i - 0) + m_i l_i + m_w c_w (t_w - 0) =$

$= 3 \times 2100 \times 10 + 3 \times 3300 + 3 \times 4200 \times 20 =$

$= 63\,000 + 9900 + 252\,000 = \underline{325\,kJ}$

3. $P = 2\,kW$
$t_1 = 20°C$
$m_w = 1.5\,kg$
$c_w = 4200 \frac{J}{kg\,K}$

$P = \frac{W}{t} = \frac{Q}{t} \Rightarrow Q = m_w c_w \Delta t = P \cdot t$

$\frac{m_w c_w \Delta t}{P} = t$

$252\,s = t$

$t = 4\,min\ 12\,s$